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ORIGINAL ARTICLE

The Role of Personality in Relation to Gender Differences in School Subject Choices in Pre-University Education

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Abstract Boys and girls to some extent differ in personality characteristics while they also prefer different school subjects in secondary education. This study has attempted to unravel the relations among gender, personality, and students' subject choices. The study was based on a sample of 1,740 9th grade pre-university students throughout the Netherlands (average age 15 years). We used the Five-Factor Personality Inventory (FFPI) of Hendriks, Hofstee, and De Raad (1999a) to measure the students' personalities. The research questions were: (1) *To what extent are students' personality characteristics related to their subject choices in secondary education?* (2) *Do students' personality characteristics mediate the gender – subject choice relation? And if yes, which personality characteristics are responsible for this?* (3) *Is the relation between personality characteristics and subject choices different for boys and girls?* We found several associations between personality characteristics and students' subject choices. Although the relationship between gender and students' subject choices was slightly attenuated after the inclusion of the personality characteristics in the multinomial logistic regression analyses, gender remained an important predictor of the students' choices. The personality factor Extraversion partially mediated the relation between gender and students' choice of advanced mathematics, chemistry, and physics versus a more language and culturally-oriented set of school subjects. Furthermore, gender was found to moderate the relation between the personality factor Autonomy and students' choice of advanced mathematics, chemistry, and physics versus a more language and culturally-oriented set of school courses.

Keywords Personality · Gender differences · Subject choices · Vocational interests · Secondary education · Mediation · Moderation

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Introduction

This study attempts to unravel the relations among gender, personality, and students' subject choices in pre-university education in the Netherlands. The rationale for this study is that despite the two facts that (1) Dutch boys and girls favour different school subjects (Korpershoek 2010; Statistics Netherlands 2011) and (2) boys and girls differ in personality to some extent (Hendriks et al. 2008), personality characteristics are usually not included as explanatory variables in educational choice models, for example, models that attempt to explain why few girls choose advanced mathematics, chemistry, and physics in upper secondary education (e.g. Van Langen 2005 for a Dutch example) and/or participate in science-oriented studies in higher education (Ceci et al. 2009 for a U.S. example). Therefore, the present study investigates whether the gender differences in school subject choices in the Netherlands are (partially) explained by students' personality characteristics (mediation) and/or whether the relation between personality and subject choices is different for male and female students (moderation). The research questions are: (1) *To what extent are students' personality characteristics related to their subject choices in secondary education?* (2) *Do students' personality characteristics mediate the gender – subject choice relation? And if yes, which personality characteristics are responsible for this?* (3) *Is the relation between personality characteristics and subject choices different for boys and girls?*

Throughout the present study, we focus on the issue that particularly few girls opt for advanced mathematics, chemistry, and physics courses when these school subjects become optional in the upper years of Dutch secondary education (Statistics Netherlands 2011). These low participation rates of girls in advanced mathematics and science courses in secondary education are undesirable, leading to an unbalanced entry in the science-oriented studies (e.g. Korpershoek 2010) and less suitable career choices (Watt and Eccles 2008). Despite the reasonable science proficiency levels of the girls in Dutch secondary education (see for example the Dutch results in the TIMMS 2003 study, Else-Quest et al. 2010), schools fail to stimulate many of them to pursue science-related careers (Organisation for Economic Co-operation and Development 2009). The present paper elaborates on these gender differences in school subject choices by putting forward the idea that gender differences in personality might partly explain the gender – subject choice relation. From research of Boone et al. (2004) conducted in Austria we know that different personality characteristics are related to different professional interests and preferences. Because the labour market of Austria and the Netherlands are more or less similar, it is plausible that similar relations exist among Dutch students. The results of Boone et al. (2004) suggest that differences in personality could partly explain boys' and girls' different school subject preferences.

Hence, the present study elaborates on Van Langen (2005), who investigated why few girls opt for advanced math/science courses in the Netherlands. Moreover, it elaborates on several previous papers published in Sex Roles, such as the study of Crombie et al. (2005) that investigated why boys and girls tend to choose different school subjects in Canada, and the study of Morgan et al. (2001) that investigated how college students perceive science-related careers in the U.S. The role of personality in relation to gender differences in school subject choices has not been the object of study in these papers. Therefore, we believe that because of the small gender differences in personality characteristics (Hendriks et al. 2008), it is important to study the relation among gender, personality, and school subject choices in addition to the current body of knowledge on gender differences in school subject choices. Moreover, since gender differences in students' school subject choices and in their personality characteristics are present in most Western developed countries (e.g. in Belgium (Flanders), the U.K. and Sweden, and also outside Europe, e.g. in the U.S., as will be discussed later), the present paper is expected to complement to the current international discussion on gender differences in math/science uptake in upper secondary education.

In the next two paragraphs, we shortly sketch the Dutch context by shortly elaborating on gender differences in students' school subject choices and gender differences in personality in the Netherlands. Subsequently, the theoretical framework elaborates more extensively on these facts. In the theoretical framework, we first introduce current findings on the relation between vocational interests and personality characteristics. Second, we present several Dutch and non-Dutch studies that have attempted to explain why girls do not choose math/science. Finally, we state some theoretical notions why we believe that personality characteristics of students should be included in educational choice models.

Gender Differences in students' School Subject Choices in Dutch Secondary Education

Boys and girls in Dutch secondary education largely differ in their school subject preferences. Whereas boys either prefer economics or science-oriented subjects such as advanced mathematics, chemistry, and physics, girls usually opt for more socially-oriented courses such as biology, foreign languages and arts (Korpershoek 2010; Statistics Netherlands 2011). In Dutch higher education, boys are highly overrepresented in math/science-related studies and in technical studies, whereas girls are overrepresented in the medical and social sciences (Statistics Netherlands 2011). Many researchers in the Netherlands (see for example Uerz et al. 2004; Van Langen 2005) and abroad (e.g. in Canada: Crombie et al. 2005) have investigated why boys and girls tend to choose different school subjects. In most studies, the choice of (advanced) mathematics has formed the core interest, especially addressing the issue why so few girls choose (advanced) mathematics in the upper years of secondary education. Sells (1980. p.1) argues that mathematics serves as a "critical filter" when students (girls in particular) fail to take high school mathematics when it becomes optional. Two common factors explaining gender differences in math choice are gender differences in the perceived difficulty of mathematics (e.g. Crombie et al. 2005 in Canada) and differences in boys' and girls' attitudes toward mathematics (e.g. Dryler 1999 in Sweden). Also in the Netherlands, girls tend to perceive math/science subjects as relatively difficult compared to boys (e.g. Stokking 2000). Unfortunately, differences in attitudes toward mathematics have, to our knowledge, not recently been object of study in the Netherlands. As an example, Crombie et al. (2005) found that girls generally have lower math competence beliefs than boys and, subsequently, tend to avoid mathematics courses whenever possible, even when they perform equally well at mathematics tests as boys. Furthermore, girls' and boys' attitudes toward specific school subjects differ to a certain extent, for example, their attitudes toward science-related domains (e.g. Dryler 1999). A more extensive overview of common explanatory factors is included in the theoretical framework.

Gender Differences in Personality Characteristics in the Netherlands

Several studies have shown that there are significant differences in personality characteristics between boys and girls (e.g. Costa et al. 2001 for an international comparison in 26 cultures across the world; Goldberg et al. 1998 for a U.S. sample; Hendriks et al. 2008 for a Dutch sample). Scholars often use the Big-Five factor structure of Goldberg (1993) to describe people's personality characteristics, using five dimensions: Extraversion, Agreeableness, Conscientiousness, Emotional Stability (or inverse Neuroticism), and Openness to Experience (NEO-PI-R; Costa and McCrae 1992) or Autonomy (FFPI; Hendriks et al. 1999a, b). In general, these five factors represent the following personality characteristics. Extraverted individuals seek other people's company and are talkative and active, whereas introverted individuals prefer to be left alone. Furthermore, agreeable individuals are mild, whereas disagreeable one's are, for example, more bossy and competitive. Conscientiousness refers to how individuals perform tasks (e.g. organized versus chaotic). The fourth factor, Emotional Stability, describes one's level of emotional reactivity (calm versus easily overwhelmed by emotions). The fifth factor of the FFPI, Autonomy, suggests that autonomous individuals are characterized by independent thought and decision making, whereas non-autonomous individuals follow the crowd (Hendriks et al. 1999a, b). The fifth factor of the NEO-PI-R, openness to experience, indicates whether people have an active imagination and intellectual curiosity or not. In correspondence with international findings, the study of Hendriks et al. (2008) revealed that, on average, Dutch boys score higher on the personality factor Emotional Stability and lower on the factors Agreeableness and Extraversion than Dutch girls.

Theoretical Framework

Vocational Interests and Personality Characteristics

A number of non-Dutch studies suggest that people's interests are somehow related to their personality characteristics (Boone et al. 2004, Austria; Elsworth et al. 1999, Australia; Holland 1997, U.S.; Rosenbloom et al. 2008, U.S.). Whether these results hold in Dutch samples is unknown. The theory of Holland (1997), for instance, states that vocational interests are an expression of personality. The theory further argues that people select environments in which they can express their interests, for example a particular field of study, and that these environments are influenced by the people within them. Holland claims that six interest types explain people's vocational preferences: *realistic, investigative, artistic, social, enterprising,* and *conventional* interests (RIASEC), also called the Big Six. The higher the congruence between personal characteristics and job requirements, the greater the likelihood of success (e.g. productivity and satisfaction; Klein and Weiner 1977, U.S.). Hence, people might implicitly select environments that fit their personality, for instance, conscientious people might prefer working as data analysts instead of sales managers. In this vein, Borges and Osmon (2001) relate medical specialty choice to personality and report significant differences in personality characteristics among medical specialty groups in the U.S. (i.e. general surgeons, anaesthesiologists, or family practice physicians). For example, family practitioners differ significantly from general surgeons and anaesthesiologists with regard to rule-consciousness (one of the traits included in the 16PF personality questionnaire of Cattell et al. 1993). In other words, surgeons are less likely to follow rules and regulations, whereas family practitioners are more compliance-ridden.

As described earlier, personality can be described alongside five dimensions: Extraversion, Agreeableness, Conscientiousness, Emotional Stability (or inverse Neuroticism), and Openness to Experience or Autonomy. Several studies addressing the relationship between personality and vocational interests established that the personality factor Extraversion is positively related to *social* and *enterprising* interests while the personality factor Openness to Experience is favourably associated with *artistic* and *investigative* interests (e.g. Larson et al. 2002 for an international meta-analysis concerning these relationships). These relations are practically the same for both genders (De Fruyt and Mervielde 1997, Belgium [Flanders]; Larson et al. 2002; Tokar and Swanson 1995, U.S.). Furthermore, a study by Hong and Lin (2010) conducted in Taiwan revealed that students who score high on Agreeableness, Extraversion, and Conscientiousness are more likely to have a more positive attitude toward science. These Asian findings, however, cannot be generalized to the Dutch situation, because of the large cultural differences between the two countries (e.g. regarding students' general interest in science). Furthermore, Lounsbury et al. (2009) studied the personality characteristics of U.S. students pursuing business and non-business majors and found that the former group scored lower on Agreeableness and higher on Conscientiousness, Emotional Stability, and Extraversion than the latter group of students. Being emotionally stable and not too agreeable apparently fits a business-oriented career in which it is common to be self-employed or work freelance.

Assuming that students are attracted to school subjects that provide them with career perspectives that in their perception "fit them", students' subject choices in secondary education are likely to be related to their personality (De Fruyt and Mervielde 1996). In addition, students' subject choices reflect, at least partly, their professional preferences.

In two studies (Korpershoek et al. 2010, conducted in the Netherlands; Lapan et al. 1996, conducted in the U.S.) Extraversion was found to be negatively associated with students' choice of math/science, which provides support for this assumption. People who score low on Extraversion are characterized as more reserved and less talkative and energetic than those who score high on this factor (Costa and McCrae 1992). The finding that Extraversion is negatively associated with students' choice of math/science, fits the stereotyped image of science as a "nerdy" subject. Additionally, Korpershoek et al. (2010) report that Conscientiousness was positively related to students' choice of math/science, although this difference was much smaller than for Extraversion. Furthermore, the study reports small differences in Agreeableness, Emotional Stability and Autonomy among the different student groups (e.g. students pursuing the more language- and culturally-oriented school subjects versus the more economy-related school subjects).

Why Girls do not Choose Math/Science

In most Western developed countries, advanced mathematics, chemistry, and physics are not obligatory courses in the upper years of secondary education (from the 10th grade onwards), while all students have pursued at least several years of basic courses in these subjects (see Van Langen and Dekkers 2005 for a comparison across the Netherlands, Sweden, the U.K., and the U.S.). Despite similarities concerning the underrepresentation of women in math/science-related fields, these countries differ considerably from each other concerning the percentages of females in these fields (Van Langen and Dekkers 2005). As compared to Sweden and the U.K., the situation in the Netherlands and the U.S. is more problematic because of the limited number of so-called 'entry' points in different segments of the STEM pipeline (STEM stands for science, technology, engineering, and mathematics; Van Langen and Dekkers 2005). Once girls drop advanced mathematics, chemistry, and physics in upper secondary education, it is difficult (and uncommon) to enter a science-oriented study in higher education (Korpershoek 2010).

As will be discussed in this paragraph, examples of common explanatory factors regarding math/science uptake in upper secondary education are the following: (1) background characteristics, for instance, gender and socioeconomic status, (2) ability, (3) perceived difficulty of specific school subjects and expectations of success in those subjects, and (4) attitudes toward specific school subjects, for example, toward science-related domains. In this paragraph, we present the findings of important studies on these four factors conducted in upper secondary education in the Netherlands and report on some consistent findings from other Western developed countries.

With respect to background characteristics, it is found that boys and students with higher socioeconomic background more often choose a science-oriented set of school subjects (e.g. advanced mathematics) than girls and students from less privileged families (Uerz et al. 2004; Van Langen 2005, the Netherlands). Similar results regarding gender differences in students' choice of school science and technology are found in secondary schools in (amongst others) Flanders (Pinxten et al. 2012), Scotland (Roger and Duffield 2000), Sweden (Van Langen and Dekkers 2005), the U.K. (Smith 2010), and the U.S. (Van Langen and Dekkers 2005). Furthermore, students normally choose school subjects in which they performed well in the past. That is, students' prior school performance in mathematics, chemistry, and physics is related to their choice of these school subjects in the upper years of Dutch secondary education (Uerz et al. 2004; Van Langen 2005). In Flanders, evidence was found for a reciprocal relationship between mathematics participation (i.e. the number of hours of mathematics instruction per week) and achievement (Van de Gaer et al. 2008). Similar to the educational system in the Netherlands, upper secondary education in Flanders is divided into several fixed study programs with or without a strong emphasis on mathematics (Van Langen and Dekkers 2005). Van de Gaer et al. (2008) found that boys tend to choose mathematics-oriented study programs in upper secondary education more often and they also achieve higher in mathematics than girls in these upper years. In both Flanders and the Netherlands, however, girls often do not aspire to a science-related career even though they perform adequately well in mathematics (Korpershoek 2010, the Netherlands; Van de Gaer et al. 2008, Flanders; see also Ceci et al. 2009 for similar findings in the U.S.). In a similar vein, Dutch boys and girls differ in their perception of the difficulty of physics and their expectations of success in that subject (e.g. Stokking 2000). Gender differences in the perceived difficulty of science-oriented school subjects are found in many developed European countries such as Sweden (Jonsson 1999), Italy (Muzzatti and Agnoli 2007), Scotland (Roger and Duffield 2000), and the U.K. (Woolnough 1994), and outside Europe as well, for example, in Canada (Crombie et al. 2005) and the U.S. (Eccles et al. 1985; Stipek and Gralinski 1991). It is generally assumed that gender differences in self-confidence (see e.g. Steinmayr and Spinath 2009, conducted in Germany) and self-efficacy beliefs regarding mathematics (Crombie et al. 2005, Canada) underlie the reported gender differences in perceived difficulty of mathematics. Moreover, several international review studies report that girls often have less favourable attitudes towards mathematics than boys (Dryler 1999, Sweden; Frost et al. 1994, U.S.; see Osborne et al. 2003 and Weinburgh 1995 for international review studies

on this topic). In the Netherlands, gender differences in students' attitudes towards mathematics are expected to be in line with these findings, however, empirical data are, to our knowledge, unavailable. One recent paper of Korpershoek et al. (2012) reports, however, that no large gender differences in attitudes toward science-oriented studies are present in the Netherlands. Whether students assess advanced mathematics, chemistry, and physics as typically masculine has not been studied recently in this country. By contrast, the underrepresentation of Dutch women in STEM-related fields suggests a cultural and persistent belief that such a career is unsuitable for girls (see e.g. the study of Correll 2001 about culturally biased self-assessments regarding particular career choices in the U.S.).

Gender Differences in Personality; A Neglected Factor?

So far, however, it has not been confirmed whether personality is related to students' subject choices in education in addition to the factors reported on in the previous paragraph. Moreover, whether this relation is different for male and female students is unknown. Therefore, in the present study, we investigated the role of personality in relation to gender differences in school subject choices in secondary education. There are two reasons why we believe that personality is related to a difference in subject choices between boys and girls. First, as we stated previously, boys and girls differ to a certain extent in their personality characteristics (e.g. Hendriks et al. 2008). We expected that these gender differences in personality partly explained their different subject choices. Second, several international studies have reported on consistent relations between personality characteristics and vocational interests (e.g. Larson et al. 2002). Hence, our second reason to relate personality to boys' and girls' subject choices was that students' school subject preferences are systematically related to their vocational interests (Elsworth et al. 1999). Following the results of the earlier studies, we also expected personality to be related to boys' and girls' subject choices in secondary education (see also Korpershoek et al. 2010).

As stated by Walsh (2001), there is a need for broadening the perspective of person-environment psychology (p. 264). When addressing occupational choices scholars tend to focus on adult or college freshman samples instead of on younger students, whereas it would make sense to investigate the choices made by the last group in secondary school. Moreover, previous studies on students' subject choices in education barely make use of the findings of the extensive research literature on the relationship between personality and vocational interests. Students' choices are a fair representation of their (initial) vocational interests. Since during secondary education they in fact make preliminary career choices, we have attempted to elaborate on this field by specifically addressing the personality – vocational interest relationship in secondary education.

The Present Study

The present paper has especially focused on three related issues.

First, we examined to what extent personality characteristics are related to students' subject choices in secondary education. As indicated in our theoretical framework, we started from the suggestion that the personality factor Extraversion is negatively and Conscientiousness positively related to students' choice of advanced mathematics, chemistry, and physics in the Netherlands (*hypothesis 1*). For the personality factors Agreeableness, Emotional Stability, and Autonomy, no specific hypotheses were formulated since the study of Korpershoek et al. (2010) did not report differences between students pursuing advanced math, chemistry, and physics and other students concerning these factors. Exploratory analyses are included for these factors in the results section.

Second, we investigated whether and which personality characteristics explain the relation between gender and students' subject choices. For this purpose we analysed whether personality characteristics mediate the gender – subject choice relation. We first tested whether boys and girls in our sample differed in their school subject choices in accordance with previous findings in the Netherlands. We expected that boys would favour the more science- and economy-oriented school subjects, whereas girls would favour the more language- and society-oriented school subjects (*hypothesis 2*). Consistent evidence is found in both the Netherlands as well as in the U.S. that gender is related to students' choice of math/science (e.g. Eccles et al. 1985; Eccles 1987, 2005; Van Langen 2005). Then, we tested whether the gender differences in personality characteristics in our sample were in accordance with the literature (Hendriks et al. 2008), that is, whether boys had higher scores on Emotional Stability and lower scores on Extraversion and Agreeableness than girls (*hypothesis 3*). Given the fact that girls are generally somewhat more extraverted than boys, we expected that Extraversion would partially mediate the relation between gender and students' choices of math/science (*hypothesis 4*). Exploratory analyses are conducted for possible mediated effects of the other personality factors. We did not hypothesize a mediation effect of Conscientiousness, because we did not expect gender differences regarding this factor.

Third, we explored whether the relation between personality and subject choices was different for male and female students. That is, we explored whether gender served as a moderator of this relationship. As there is no theory available on this topic, we did not formulate any specific hypotheses about moderation. Instead, exploratory analyses

including interaction terms among gender and the five personality factors are presented in the results section.

In the present study, students' mathematical ability (based on students' score on an arithmetic test, a symbolic intelligence test, and a mathematics test; see method section) was taken into account when explaining students' subject choices. In Dutch pre-university education, students' mathematical ability is more strongly related to their choice of school subjects than their general cognitive ability (and e.g. their verbal intelligence; De Boer et al. 2010). Therefore, we controlled for students' mathematical ability in our analyses.

In summary, the we tested the following hypotheses:

1) Extraversion is negatively and Conscientiousness positively related to students' choice of advanced math, chemistry, and physics.
2) Boys favour science- and economy-oriented school subjects, whereas girls favour language- and society-oriented school subjects.
3) Boys score higher on Emotional Stability than girls, whereas girls score higher on Extraversion and Agreeableness than boys.
4) Extraversion partially mediates the relation between gender and students' choice of advanced mathematics, chemistry, and physics.

In this paper, we presented descriptive results for the associations between gender and students' school subject choices (*hypothesis 2,* presented in Table 1), between gender differences and personality characteristics (*hypothesis 3,* presented in Tables 2 and 4), and between personality characteristics and students' school subject choices (*hypothesis 1,* presented in Table 3). Subsequently, multinomial logistic regression analyses were used to test five models, each including different sets of explanatory variables (see Table 5). Model 0 is the unconditional model with no predictors. Model 1a (which includes gender as predictor) tests *hypothesis 2* whether boys favour science- and economy-oriented school subjects, whereas girls favour language- and society-oriented school subjects. Because of the impact of students' math ability on their school subject choices, Model 1b tests whether *hypothesis 2* holds when the effect of math ability on students' choice is taken into account. Model 2 also includes the five personality factors and tests whether personality mediates the relation between gender and students' choice of advanced mathematics, chemistry, and physics (*hypothesis 4*). Finally, Model 3 also includes the two-way interactions between gender and the five personality characteristics to explore whether the relation between personality and school subject choices was different for male and female students (moderation, no hypothesis specified).

Table 1 Students' study profile choices (split by gender)

	Boys		Girls	
	N	%	*N*	%
SCIENCE[ab]	224	28.8	30	3.1
HEALTH[ab]	188	24.1	327	34.0
ECONOMY[ab]	313	40.2	276	28.7
CULTURE[ab]	54	6.9	328	34.1
Total	779	100.0	961	100.0

[a] The gender differences were significant ($p<.001$); [b] The study profiles stand for: science & technology (SCIENCE), science & health (HEALTH), economics & society (ECONOMY), and culture & society (CULTURE)

Method

Participants

The study included 779 boys (45 %) and 961 girls (55 %) throughout the Netherlands in the 9th grade of pre-university education (average age 15 years), which is the highest level track of the Dutch secondary education system. Around 20 % of the student population in the Netherlands currently pursues this track. In our sample, 87 % of the students is categorised as native Dutch students and 13 % is categorised as ethnic minority students (mostly from non-Western European countries, e.g. Indonesia). The data used formed part of a large-scale longitudinal study conducted in the Netherlands, the "Cohort Studies in Secondary Education" (VOCL'99). The complete VOCL'99 sample represents all schools and students in all tracks of the Dutch secondary education (Kuyper and Van der Werf 2003). The participants in the current study were selected based on the availability of a measure of personality and math ability. The group of 1,740 selected students (58 %) represented the overall VOCL'99 sample of pre-university students (N= 2,999) with respect to gender and socioeconomic status. The selected students came from 70 different schools throughout the Netherlands.

The students in our sample had chosen one of four "study profiles", which are combinations of school subjects in which the final school examinations are taken (see next paragraph). Table 1 shows additional information regarding the student sample, that is, their study profile chosen and their gender.

While boys chose the SCIENCE and ECONOMY profiles more often, girls opted more frequently for the HEALTH and CULTURE programs. In the study profile choices the gender differences appeared to be highly significant, χ^2 (3)=369.55, $p<.001$, which confirms *hypothesis 2.*

Table 2 Students' average score on the five personality factors and math ability, split by study profile and gender

	SCIENCE [c]	HEALTH [c]	ECONOMY [c]	CULTURE [c]	Total	Standard deviation
Boys:						
Extraversion[a]	.68	.92	1.05	1.26	.93	.97
Agreeableness[a]	1.60	1.80	1.46	1.58	1.59	.99
Conscientiousness[a]	.24	.21	.19	−.03	.19	1.17
Emotional Stability[a]	1.55	1.40	1.49	1.30	1.47**	.82
Autonomy[a]	.75	.77	.71	1.10	.76	.88
Math ability[b]	1.17	.83	.58	.48	.80**	.89
N boys	224	188	313	54	779	
Girls:						
Extraversion[a]	.91	1.18	1.33	1.36	1.27**	.97
Agreeableness[a]	2.33	2.28	2.06	2.42	2.27**	.93
Conscientiousness[a]	.22	.10	.20	−.01	.09	1.17
Emotional Stability[a]	.88	.91	.82	.65	.79	1.00
Autonomy[a]	1.13	.81	.79	.98	.87*	.94
Math ability[b]	1.36	.72	.38	.12	.44	.89
N girls	30	327	276	328	961	

*$p<.01$, **$p<.001$ for the gender differences (the asterisks are placed at the highest score); [a] These scores are anchored factor scores (Hofstee and Hendriks 1998), which are standardized scores anchored at the midpoint of each scale. Consequently, their means could differ from zero. [b] These scores are standardized scores (z-scores). [c] The study profiles stand for: science & technology (SCIENCE), science & health (HEALTH), economics & society (ECONOMY), and culture & society (CULTURE)

Variables and Instruments

Study Profile Choice

The Dutch secondary educational system was extensively changed in 1998. A new educational concept was introduced in the upper years of the two tracks that prepare for higher education. All schools for senior general secondary education and pre-university education implemented this new educational concept called "the second stage of secondary education". The objective was threefold: (1) to improve the link between secondary education and higher education, (2) to modernize the study programs in upper secondary education and to give students a more focused preparation in recognizable and more coherent study programs for specific courses in higher education, and (3) to give schools more freedom in method choice in the study program for upper secondary education. One of the mandatory changes was the introduction of four study profiles. The study profiles were developed to give students a better preparation for the sectors in which our society is divided; science & technology (SCIENCE), science & health (HEALTH), economics & society (ECONOMY), and culture & society (CULTURE). Students have to choose one of four study profiles at the end of the third year. Formally, the study profile choice is unrestricted and mainly based on students' interests and ambitions. Meanwhile, students' aspirations can be restricted to some extent due to their prior performance on particular subjects or the negative advice of parents, teachers, and school counsellors. Hence, the distribution of students across the study profiles is rather unequal and the choices are highly gender specific (see Table 1). In the SCIENCE profile advanced mathematics, chemistry, and physics are mandatory. Although the HEALTH profile also includes these subjects less time is spent on them as their content is more elementary and less science-oriented. The ECONOMY and CULTURE profiles roughly consist of applied mathematics (both), history (both), economics (ECONOMY), and modern languages (CULTURE). In addition to the subjects specific for a profile, all students must follow a number of mandatory subjects such as Dutch and English language plus a number of elective courses. The

Table 3 Multivariate analysis of covariance for the five personality factors (Profile x Gender MANCOVA with Math ability as covariate; N=1,740)

	F	df	p-value	η^2
Mathematical ability	5.58	5, 1727	.00*	.02
Profile[a]	4.26	15, 5187	.00*	.01
Gender	52.31	5, 1727	.00*	.13
Profile[a] × Gender	1.09	15, 5187	.36	.00

*$p<.001$; [a] Profile refers to the four study profiles science & technology (SCIENCE), science & health (HEALTH), economics & society (ECONOMY), and culture & society (CULTURE)

study profile choice is normally based on students' abilities, interests and ambitions. The students' study profile choices were provided by Statistics Netherlands. Less than 1 % of the students had chosen two instead of one profile; usually a combination of SCIENCE and HEALTH or a combination of ECONOMY and CULTURE. The study profile choices of these students were recoded as the most science-oriented profile.

Personality Characteristics

For measuring the students' personality characteristics we used the Dutch version of the Five-Factor Personality Inventory (FFPI) of Hendriks et al. (1999a, b). The questionnaire for the 9th grade was administered by the schools in the VOCL'99 study. It consisted of 100 items on a five-point scale; 10 positively and 10 negatively formulated items represent each of the Big-Five personality factors, for example: *"I like to chat"* [in Dutch: "Ik praat graag"] (Extraversion; in Dutch: Extraversie), *"I try to prevent quarrels"* [in Dutch: "Ik probeer ruzie te voorkomen"] (Agreeableness; in Dutch: Mildheid), *"I work hard"* [in Dutch: "Ik werk hard"] (Conscientiousness; in Dutch: Ordelijkheid), *"I keep my emotions under control"* [in Dutch: "Ik heb mijn emoties onder controle"] (Emotional Stability; in Dutch: Emotionele Stabiliteit), and *"I decide things on my own"* [in Dutch: "Ik neem zelf beslissingen"] (Autonomy, in Dutch: Autonomie). The original FFPI items were published in Dutch. The answer categories ran from *not at all applicable* (1) to *entirely applicable* (5). The FFPI was made using a factor analytic scoring program yielding five *compatible anchored factor scores* (Hofstee and Hendriks 1998), which are standardized scores anchored at the midpoint of each scale. The scores were computed as weighted linear combinations of the students' responses to the 100 items. Consequently, their means could differ from zero, which is why in the overall sample the five factors were not correlated. The reliability coefficients (stratified-alpha) of the five factors were Extraversion (α=.84), Agreeableness (α=.82), Conscientiousness (α=.84), Emotional Stability (α=.83), and Autonomy (α=.72). The factor scores were found to be factorially valid for this age group (Hendriks et al. 2010), and met the predictive validity (e.g. for school success; Lubbers et al. 2010) and the discriminative validity criteria (e.g. between boys and girls; Hendriks et al. 2008).

Mathematical Ability

We used three math-related tests to measure the students' math ability, after which a combined math ability score was calculated for each student. The combination of these three tests yields a highly reliable measure of students' math ability. The first test was an arithmetic test administered in the 7th grade, developed by the Dutch National Institute for Educational Testing (Cito). The reliability (α) of the test is .83. The test included 20 multiple choice items that covered the topics (1) numbers and calculations, (2) proportions, fractions, and percentages, and (3) measuring, geometry, time, and money. Second, an intelligence test was used (the Groninger Intelligentietest voor Voortgezet Onderwijs [the Groningen Intelligence Test for Secondary Education], Van Dijk and Tellegen 1994). The test was administered in the 8th grade. It consisted of a verbal and a symbolic intelligence part of which the scores on symbolic intelligence were used (α was .93). The symbolic intelligence part covered the topics numbers (25 items) and filling in symbols (20 items). Third, a mathematics test for the 9th grade was used (also developed by Cito), of which the reliability (α) was .78. This test had 33 multiple choice items, covering four topics: (1) arithmetic, measuring, and estimation, (2) algebra/relations/graphs/functions, (3) geometry, and (4) statistics and probabilities. A combined math ability score was calculated for students who had completed at least two of these three tests. In the combined score, possible differences in weight (of the tests) were taken into account by using regression coefficients as weights. The average score on math ability for pre-university students in our sample was .60 (standard deviation .90). The estimated stratified-alpha reliability of this measure (following recommendations of Kamata et al. 2003) was .92. More information about the procedure can be requested from the corresponding author.

Results

Descriptive Results

Table 2 presents the descriptive results (means and standard deviations) of the students' scores on the personality factors Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Autonomy and on math ability (the covariate). It includes separate results for the boys and girls. In addition, the results are shown for the boys and the girls within the four study profiles SCIENCE, HEALTH, ECONOMY, and CULTURE.

Table 2 shows significant associations between gender and the personality factors Extraversion, Agreeableness, and Emotional Stability, and more moderate relations between gender and Autonomy. We did not find a significant association between gender and Conscientiousness. These findings confirm prior research results that boys (on average) score higher on Emotional Stability and lower on Agreeableness and Extraversion than girls (which confirms *hypothesis 3*). Additionally, in our sample boys scored somewhat lower on Autonomy than girls. The effect sizes

(Cohen's d) for the gender differences (without taking math ability into account) are respectively: Extraversion (.35), Agreeableness (.71), Conscientiousness (.09), Emotional Stability (.74), and Autonomy (.12).

Additionally, Table 2 shows moderate differences in personality characteristics among students who pursue different study profiles. Particularly between SCIENCE and CULTURE students a major difference is found with respect to Extraversion while the differences regarding the other personality factors are smaller. Comparing all four profiles, SCIENCE students appear to have scored somewhat lower on Extraversion than the students who pursue the HEALTH, ECONOMY, or CULTURE profiles. The more science-oriented the study profile chosen, the lower students' score on Extraversion. This difference is found for both genders. Furthermore, the descriptive results for math ability show that the more science-oriented students' study profile, the higher their score on math ability, that is, SCIENCE students have the highest scores, followed by HEALTH and ECONOMY, and CULTURE students have the lowest scores on this variable. The differences among in personality characteristics among students who pursue different study profiles are tested statistically in a multivariate analysis of covariance (see Table 3). We included profile (to test *hypothesis 1*), gender, and their interaction in the analysis. Because of the large differences in math ability among the students, this variable was taken into account in order to test the independent relationship between gender and chosen study profile on the one hand and students' scores on the personality factors on the other hand. Thus, the design is a profile x gender MANCOVA with math ability as covariate. The effect sizes in the table (partial eta-squared) are the independent effects of each variable corrected for the effects of the other variables included in the analysis (.01 is considered a small effect, .06 as a medium effect, and .14 as a large effect).

We observed significant differences among the four profiles with respect to the personality factors (for details on the differences among the profiles see Table 1). From the contrast estimates of the MANCOVA (not reported here; they can be requested from the corresponding author) we can conclude that in the SCIENCE students only differed from students pursuing the HEALTH, ECONOMY, or CULTURE profile regarding the personality factor Extraversion. The SCIENCE students had significantly lower scores on this factor than the other students. Although we additionally expected a positive relation for Conscientiousness, this result was not found in our student sample. Therefore, *hypothesis 1* was only partly confirmed. As presented earlier, we observed significant differences between the two gender with respect to the personality characteristics (*hypothesis 3*) in Table 3. Moreover, we found a significant relation between math ability (the covariate) and the personality factors. The contract estimates showed that math ability was significantly related to Extraversion, which indicates that the higher one's score on math ability, the lower one's score on Extraversion. Finally, the interaction between gender and study profile on students' personality characteristics was not significant.

Test Results of the Regression Models

To investigate whether and which personality characteristics explained the relation between gender and students' subject choices we used Baron and Kenny's (1986) procedure to test the presumed indirect effects. We used the following procedure to test the presumed indirect effects (mediation). First, we estimated the association between gender and the mediating factors (i.e. the five personality factors), using linear regression analyses (which corresponds with *hypothesis 3*). Second, the direct association between the independent variable (i.e. gender) and the dependent variable (i.e. chosen study profile) was estimated by performing a multinomial logistic regression analysis (which corresponds with *hypothesis 2*). Third, multinomial logistic regression analysis was used, regressing the dependent variable (chosen study profile) to both the independent variable (gender) and the mediators (the personality factors) in order to test *hypothesis 4*. At each stage of the analyses, a measure of the students' math ability was included as a covariate because, in the Netherlands, this is an important factor in explaining the students' choice of math/science-related subjects (De Boer et al. 2010). In order to examine gender as a moderator of the personality – subject choice relation (exploratory analyses), we included the two-way interactions between gender and the five personality factors in the regression model described above. Although the students in our sample were nested within schools, multinomial logistic multilevel analysis could not be used to analyze the data. Too few girls (N= 30) had chosen the SCIENCE study profile (see Table 1) to conduct such an analysis. The students in our sample came from 70 different schools, which indicates that from at least 40 schools, no SCIENCE girls were included in our sample.

Based on the descriptive results presented in the previous section, we started the linear regression analyses by first estimating the association between gender and the five personality factors, that is, the presumed mediating factors. Table 4 presents the results of these analyses (which are basically student's t-tests testing the difference between the two groups). These results correspond with the descriptive results presented in Table 2, therefore, we will not repeat the results in much detail here. In accordance with the results presented earlier, it shows significant associations between gender and the personality factors Extraversion, Agreeableness, and Emotional Stability, and more moderate relations between gender and Autonomy.

Table 4 Results of linear regression analyses for the five personality factors (separate analyses for each dependent variable) (N=1,740)

			95 % confidence interval for B	
	B (SE[a])	β	Lower	Upper
Extraversion (R^2=0.03):				
Constant	.93 (.03)		.86	1.00
Gender[b]	.35 (.05)	.17**	.25	.44
Agreeableness (R^2=0.11):				
Constant	1.59 (.03)		1.53	1.66
Gender[b]	.68 (.05)	.33**	.59	.77
Conscientiousness (R^2<0.01):				
Constant	.19 (.04)		.11	.8
Gender[b]	−.10 (.06)	−.04	−.21	.01
Emotional Stability (R^2=0.12):				
Constant	1.47 (.03)		1.41	1.54
Gender[b]	−.68 (.04)	−.34**	−.77	−.59
Autonomy (R^2<0.01):				
Constant	.76 (.03)		.70	.83
Gender[b]	.11 (.04)	.06*	.02	.19

*p<.05, **p<.001. [a] Standard error. [b] Gender: boys coded 0, girls coded 1

Second, the direct association between the independent variable 'gender' and the dependent variable 'chosen study profile' was estimated using multinomial logistic regression analysis. The criterion variable was the profile chosen, namely: (1) SCIENCE, (2) HEALTH, (3) ECONOMY, or (4) CULTURE. The last category was defined as reference group. Table 5 presents the regression coefficients and standard errors. Model 0 is an unconditional model without predictors. In Model 1a the variable gender was included as a predictor and in Model 1b the covariate math ability was added to the analysis.

Model 1a shows an association between gender and chosen study profile. Boys were more likely to choose the SCIENCE, HEALTH, or ECONOMY profiles than the CULTURE profile (the reference group) as compared to girls. Girls, however, chose the HEALTH profile more often than boys (see the results of Table 1), so the gender-effect merely indicates that boys chose HEALTH more often than CULTURE (24 % vs. 7 %), whereas among the girls, equal percentages chose either HEALTH or CULTURE (both 34 %). Model 1a explained 22 % of the variance (Nagelkerke R^2) while Model 1b indicated that the gender-effect remained significant when controlling for students' math ability. The fit of the model improved significantly (as compared to the empty model) when gender and math ability were included, χ^2 (6)=585.57, p<.001. Model 1b explained 31 % of the variance (Nagelkerke R^2).

Subsequently, we added the five personality factors to the multinomial logistic regression analysis (Model 2, presented in Table 5) in order to test *hypothesis 4*. We entered them simultaneously to make sure that the mediation of each factor would be independent of the effect of the other plausible mediators (i.e. multiple mediation). Including the five personality factors in Model 2 significantly improved the fit of the model, χ^2 (21)=668.45, p<.001. It explained 34 % of the variance (Nagelkerke R^2) while the association between gender and chosen study profile remained significant. As compared to Model 1b the impact of gender on chosen study profile was attenuated somewhat by the addition of the personality factors, although the association between gender and chosen study profile remained significant in all comparisons. Extraversion partially mediated the relation between gender and chosen study profile, which confirms *hypothesis 4*. The negative regression coefficient indicates that the higher the score on Extraversion, the lower the probability of choosing SCIENCE as compared to choosing CULTURE (the reference group). Additionally, Table 5 shows that the higher the score on Agreeableness, the lower the probability of choosing SCIENCE as compared to CULTURE and in the opposite direction, the higher the score on Emotional Stability, the higher the probability of choosing SCIENCE as opposed to CULTURE.

Also in the HEALTH-CULTURE and ECONOMY-CULTURE comparisons the association between gender and chosen study profile was somewhat weakened by the addition of the personality factors, although the association remained significant in both comparisons, which also applied to the SCIENCE-CULTURE comparison. In addition to the significant association between gender and chosen study profile, we found that the regression coefficients of Extraversion and Emotional Stability were significant in the HEALTH-CULTURE comparison. Similar to the SCIENCE-CULTURE comparison, we established a negative association between Extraversion and choosing HEALTH instead of CULTURE and a positive relation between Emotional Stability and choosing HEALTH rather than CULTURE. In the ECONOMY-CULTURE comparison the regression coefficient of Extraversion was not significant, in contrast to the results of the first two comparisons. The regression coefficients of Agreeableness and Autonomy were negative, indicating that the higher the score on these factors, the lower the probability of choosing ECONOMY as compared to CULTURE. Both personality factors Conscientiousness and Emotional Stability had significant positive regression coefficients, which means that the higher the score

Table 5 Results of multinomial logistic regression analyses of students' study profile choice. Beta coefficients (standard errors between brackets) are presented for each model (N=1,740)

	Model 0	Model 1a	Model 1b	Model 2	Model 3
SCIENCE[a] versus CULTURE[a]:					
Constant	−.41 (.08)***	−2.39 (.19)***	−3.17 (.22)***	−2.14 (.35)***	−2.98 (.67)***
Gender (boys)		3.81 (.24)***	3.62 (.25)***	3.09 (.27)***	4.12 (.80)***
Math ability			1.29 (.12)***	1.25 (.12)***	1.25 (.12)***
Extraversion				−.43 (.10)***	−.57 (.18)**
Agreeableness				−.36 (.10)***	.19 (.17)
Conscientiousness				.13 (.08)	.08 (.14)
Emotional Stability				.35 (.11)**	.32 (.20)
Autonomy				.01 (.11)	−.29 (.19)
Interaction Gender × Extraversion					.16 (.26)
Interaction Gender × Agreeableness					.03 (.28)
Interaction Gender × Conscientiousness					.17 (.22)
Interaction Gender × Emotional Stability					−.01 (.29)
Interaction Gender × Autonomy					.68 (.29)*
HEALTH[a] versus CULTURE[a]:					
Constant	.30 (.07)***	−.00 (.08)	−3.17 (.22)***	.10 (.25)	.15 (.28)
Gender (boys)		1.25 (.17)***	3.62 (.25)***	.86 (.19)***	1.02 (.54)
Math ability			1.29 (.12)***	.78 (.09)***	.78 (.09)***
Extraversion				−.16 (.08)*	−.27 (.18)
Agreeableness				−.12 (.08)	.15 (.17)
Conscientiousness				.11 (.06)	.09 (.14)
Emotional Stability				.20 (.08)**	.00 (.20)
Autonomy				−.12 (.08)	−.37 (.19)*
Interaction Gender × Extraversion					.13 (.20)
Interaction Gender × Agreeableness					−.34 (.19)
Interaction Gender × Conscientiousness					.01 (.15)
Interaction Gender × Emotional Stability					.26 (.22)
Interaction Gender × Autonomy					.29 (.21)
ECONOMY[a] versus CULTURE[a]:					
Constant	.43 (.07)***	−.17 (.08)**	−.27 (.09)**	.67 (.24)**	.72 (.28)*
Gender (boys)		1.93 (.17)***	1.87 (.17)***	1.46 (.19)***	1.46 (.52)**
Math ability			.36 (.08)***	.37 (.09)***	.36 (.09)***
Extraversion				−.05 (.08)	−.21 (.17)
Agreeableness				−.40 (.08)***	−.20 (.16)
Conscientiousness				.15 (.06)*	.10 (.13)
Emotional Stability				.21 (.08)**	.24 (.19)
Autonomy				−.18 (.08)*	−.41 (.18)*
Interaction Gender × Extraversion					.19 (.19)
Interaction Gender × Agreeableness					−.23 (.18)
Interaction Gender × Conscientiousness					.07 (.15)
Interaction Gender × Emotional Stability					−.08 (.21)
Interaction Gender × Autonomy					.26 (.20)

*p<.05, **p<.01, ***p<.001. [a] The study profiles stand for: science & technology (SCIENCE), science & health (HEALTH), economics & society (ECONOMY), and culture & society (CULTURE)

on these factors, the higher the probability of choosing ECONOMY as opposed to CULTURE.

Finally, we included the two-way interactions between gender and the five personality variables in the regression

analysis (Model 3). The final model is presented in Table 5. This step slightly improved the fit of the model, χ^2 (36)= 685.39, $p<.001$. The model explained 35 % of the variance (Nagelkerke R^2). Due to the inclusion of the interaction terms in the final model, some of the main effects of gender and the personality characteristics were not significant anymore, despite the fact that the interaction terms were not significant. However, the parameter estimates revealed one significant interaction in the SCIENCE-CULTURE comparison, namely between gender and Autonomy. This finding indicates that the relation between Autonomy and students' study profile choice differs for boys and girls. Table 2 indicates that on average CULTURE boys scored higher on Autonomy than SCIENCE boys, whereas CULTURE girls had lower scores on Autonomy than SCIENCE girls. In other words, in the SCIENCE-CULTURE comparison gender served as a moderator of the relation between the personality factor Autonomy and students' study profile choice.

Discussion

The primary purpose of the present study was to clarify the relations among the variables gender, personality, and students' school subject choices in secondary education. In light of the imbalance between boys and girls in math/science choice in upper secondary education and, consequently, the underrepresentation of women in science-oriented studies and careers, we examined whether the gender differences in school subject choices were (partially) explained by students' personality characteristics. Furthermore, we studies whether the relation between personality and subject choices was different for male and female students. From the descriptive results it was concluded that the personality characteristics among students pursuing different sets of school subjects (i.e. the SCIENCE, HEALTH, ECONOMY, or CULTURE profile) differed to some extent, particularly regarding the personality factor Extraversion. This result confirms our suggestion that Extraversion is negatively related to students' choice of advanced math, chemistry, and physics (*hypothesis 1*). The associations between personality characteristics and students' choice of school subjects were found to be generally consistent with those established in previous research studies conducted outside the Netherlands (Lapan et al. 1996; Lounsbury et al. 2009). Furthermore, the earlier reported result (Korpershoek et al. 2010) that Dutch students pursuing a science-oriented set of school subjects (i.e. the SCIENCE study profile) are overall less extraverted than students following other combinations of subjects was replicated in the current sample of pre-university students. Extraverted students apparently avoid science-oriented study profiles to some extent. In line with this result, Larson et al. (2002) found that Extraversion is related to the *social* and *enterprising* interests of Holland's theory. The association between Extraversion and social interests (e.g. working with people instead of things) is indicative of a persistent preconception of students that science-oriented studies and careers are relatively "a-social". Apparently, this preconception appears to present in the Netherlands to some extent as well. Maybe, students associate particular students (and also teachers) with particular school subjects. The study of Morgan et al. (2001), for example, found that college students in the U.S. perceived science-related careers as less likely to afford interpersonal goals such as helping people. A practical implication of the results presented is that, as a consequence of the overrepresentation of the more introverted students in the SCIENCE profile, stimulating introverted students to choose the SCIENCE profile in secondary education might be more effective than trying to convince extraverted students to pursue a math/science career (Korpershoek 2010). Additionally, we expected that Conscientiousness was positively related to this choice, however, this relation was not found. Therefore, we have to reject *hypothesis 1* for this variable. The differences in Conscientiousness among the different student groups were relatively small compared to the differences in Extraversion, which could explain why the small differences we found were not significant.

The multinomial logistic regression analyses indicated that students' gender is strongly related to their study profile choice. Girls in the Netherlands prefer the HEALTH and CULTURE study profiles, whereas boys prefer the SCIENCE and ECONOMY profiles (see also Korpershoek 2010; Van Langen 2005), which confirms *hypothesis 2*. In previous studies, it was found that girls often favour studies and careers that contribute to fulfilling a useful social role in society, for example, a law or medicine study (Lightbody and Siann 1997, U.K.; Lips 1992, U.S.; Mullis et al. 2009, international comparison). This is also the case in the Netherlands (Statistics Netherlands 2011). In a similar vein, Van Langen (2005) reports that Dutch girls often do not see the necessity or utility of physics for their own future and, therefore, drop this school subject as soon as possible.

Our results show that *hypothesis 3* was confirmed, indicating that in line with previous studies, boys had higher scores on Emotional Stability than girls, whereas girls had higher scores on Extraversion and Agreeableness than boys. Regarding our fourth hypothesis, we found that students' personality characteristics partially mediated the gender – subject choice relation. Following the steps of Baron and Kenny (1986), our results demonstrate that the impact of gender on chosen study profile is somewhat attenuated by the addition of the personality factors in the regression model. However, the association between gender and chosen study profile remained significant in all between-group comparisons. The most important finding was that

Extraversion partially mediated the relation between gender and students' choices of math/science, which confirms *hypothesis 4*. Moreover, our exploratory analyses showed that the relation between the personality factor Autonomy and students' subject choice differed between the boys and girls (moderation; see also Korpershoek et al. 2010). Autonomous boys chose CULTURE more often than less autonomous boys, whereas autonomous girls opted for SCIENCE more often than less autonomous girls. In deviating from the majority of the girls the more autonomous girls probably made a conscious choice because they particularly aspired to a science-related career. In a similar way the CULTURE boys deviated from the majority of the boys, which may also be explained by their higher average score on Autonomy. We did not find any significant interactions between gender and Extraversion, Agreeableness, Conscientiousness, and Emotional Stability. These findings are generally in line with the Flemish results of De Fruyt and Mervielde (1997), the international meta-analyses of Larson et al. (2002), and the study of Tokar and Swanson (1995) conducted in the U.S., who state that the relations between personality and vocational interests are (almost) similar for boys and girls. Unfortunately, due to the differences in the questionnaires used there were no previous results available concerning the personality factor Autonomy. All studies referred to use the NEO-PI-R (Costa and McCrae 1992) instead of the FFPI (Hendriks et al. 1999a). In these questionnaires the fifth factor is Openness to Experience and not Autonomy, as in our study. These two items are not quite related (correlation .20; Hendriks et al. 1999a).

Conclusions

Taking the extensive body of literature on the relationship between personality and vocational interest as our point of departure, we have attempted to enhance this field by investigating the association between personality and students' school subject choices in secondary education. Our finding, that already at the age of 15 several relations can be distinguished between personality characteristics and students' subject choices, is in our view an important contribution to this area of research. Although at this age one's personality has not yet been fully developed (Pullmann et al. 2006), the impact of these psychological characteristics on students' choices is remarkable. Based on our findings, we believe that, in addition to gender as an important explanatory variable of students' subject preferences, personality characteristics should be included in the educational choice models aimed at explaining students' subject choices (e.g. Van Langen 2005). The present study revealed that personality is related to students' school subject choices and, therefore, should be given appropriate attention in educational research. Since girls and boys differ in their personality characteristics to some extent, we explicitly suggest to include this factor when investigating the issue of why few girls opt for advanced mathematics, chemistry, and physics courses in upper secondary education. Moreover, the contribution of personality in addition to the common explanatory factors as mentioned in the theoretical framework needs to be examined further, particularly in terms of exploring personality as a possible mediator of the associations previously defined (e.g. the relation between math ability and students' choice of advanced mathematics).

Implications for Educational Practice

At this moment the results of our study are still too preliminary to draw far-reaching conclusions about their practical implications. The amount of empirical support for personality as a presumed mediator of the well-established gender – subject choice relation is still too limited based on this sole study. Another major concern is the effect of "personality sorting" in education. Although an effective educational system should be aimed at developing a match among students' abilities, personal characteristics, and various choice options such as subject choices in secondary education, it is questionable whether a higher congruency between personality and the environment leads to higher academic achievement (or, a higher degree of student satisfaction) (Schneider et al. 2000). Only few studies have addressed the effect of person-environment fit on individual performance. Moreover, with respect to personality characteristics both positive and negative consequences of homogeneity are plausible among student groups. In other words, it is as yet unknown whether a group with little variance in personality characteristics (e.g. a group of introverted students) performs better or worse than a group with much variance in this respect, for example, with respect to creative thinking processes or working coherently together on assignments. In an educational setting, an experiment could be set up to find out whether groups of students with little variance in personality characteristics perform worse or better than students in mixed personality groups when both groups work on the same group assignment.

Suggestions for Future Research

We recommend future studies to elaborate more on the relations among gender, personality, and students' subject choices to find out whether the results as presented in this study also apply to other student samples. Furthermore, more empirical support is needed to confirm our exploratory result that gender serves as a moderator of the Autonomy-subject choice relation. If Autonomy really determines the divergence rates related to conscious career decisions, it can be claimed that personality does "categorize" students into

different fields of study in education. Furthermore, several educational studies have confirmed the effect of peers on students' educational choices (see for example Leslie et al. 1998, U.S.; Van Langen and Vierke 2009, the Netherlands), but this effect may be much stronger for less autonomous students. Further analyses are needed to investigate *why* non-autonomous girls less often opt for a science-oriented study profile, and why this is particularly the case for girls as compared to non-autonomous boys. A plausible explanation is that autonomous girls are less susceptible to the negative effects of stereotype threat on their mathematics performance than non-autonomous girls and boys in general (see Lesko and Corpus 2006 and Schmader et al. 2004 for studies in the U.S. on stereotype threat among women majoring in math-related fields). Unfortunately, the issue of stereotype threat among girls in upper secondary education has not received appreciable attention in the Netherlands. The field would benefit from a more qualitative approach to explore this issue in more detail, for example, by investigating the girls' individual choice process throughout secondary education (see for example the study of Packard and Nguyen 2003 where interviews were used to identify the factors that influenced the girls' decisions to enrol in an intensive math and science programs in the U.S.). We suggest combining such a study with a more quantitative approach in which students' personality characteristics are investigated when they enter secondary education. Hence, the factors that, throughout the secondary school years, influenced girls' study profile choices can be compared across different student groups (e.g. girls with high vs. low scores on Autonomy).

Limitations of the Present Study

Some final remarks need to be made about the data used in this study. In our student sample few girls chose the SCIENCE study profile. A repetition of this analysis in a larger sample, especially one including more girls pursuing advanced mathematics, chemistry, and physics courses, would strengthen the results. In addition, as the educational system dealt with in our study is typically Dutch, our results are not easily generalizable to international student samples. It is therefore unknown whether the results will also apply to student samples in other countries with different educational systems. However, in any case they can serve as an example for future (international) studies.

Despite these limitations our study has taken the first step in unravelling the relations among gender, personality, and students' subject choices in secondary education. As suggested, a combination of both quantitative and qualitative methods is needed to further examine the relationships found in the present study. It has yielded valuable insights into these relationships, which in our view form a useful starting point for future research on this topic.

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